

SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC
PROGRESS.

JOHN MICHELS, Editor.

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SCIENCE AND MEDICINE.

A few words on the relation of the natural sciences to medicine, as one of the greatest aids for the achievement of success, should be welcome reading to all members of the medical profession whose aspirations are above the dead level of mediocrity.

The physician may at first sight desire to stifle all discussion on this point by saying, that the requirements of study involved in acquiring a knowledge of medical practice *per se* occupy too much of his time to admit of his taking up outside issues, which he considers mere refinements of practice. There are others who take the absurd view that, to add a knowledge of the natural sciences is to become in the highest sense of the word a Chemist, a Physicist, or a Biologist. Seeing that the attainment of a complete knowledge of either of these sciences, is a work of a life time, it is argued, that they are to be shunned as impossibilities.

The path of the would-be scientific medical man is made clear by the encouraging words of one of his own profession, Dr. G. Vivian Poore, M.R.C.P., who says, there is a minimum of knowledge in this respect which is sufficient to endow the physician with a *scientific grasp of his art*. What is really wanted, is sufficient knowledge to enable a medical man to read these various sciences with intelligible results for himself, *when he needs* and as often as he desires to consult them, to show him as objectively as possible, those great principles which have already found application in his healing art. This will lead him to think and enable him to act with precision in any great emergency.

Let it be understood that there is no necessity for cramming the head with a mass of details, and that our

object is to enrich and not encumber the mind of the medical practitioner.

To those who are ignorant of the advantages of some knowledge of the natural sciences in medical practices, the following observations of Dr. Poore may be read with interest.

"There are those who hold that the student of medicine has but little need of special training in the natural sciences, but such a position I believe to be untenable, and if I have to say one thing more emphatically than another to the first year's students, it is to advise them, not on any account to neglect their purely scientific studies. They are the very foundation of your professional knowledge, and without a solid foundation, no firm or worthy superstructure can be raised.

How can a man hope to rightly comprehend that most complicated of all machines, the human body, with its levers, pumps, and elastic canals, unless he be first furnished with the principles of mechanics and hydraulics? Who will say that a proper knowledge of the eye, or of the many optical instruments used in medicine, is attainable without some acquaintance with the laws of light; or that the intricacies of the ear, and the art of auscultation can at all be understood by him, who knows nothing of the laws of sound. The laws of heat must be studied in order to appreciate the difficult problems afforded by the animal temperature, its variations in health and disease, and the means of influencing it by therapeutic agents. Without the principles of chemistry we should be intellectually lost in the human laboratory, and unable to employ chemical agencies in the treatment of disease; and electricity is so correlated with the other physical sciences, and of so much service both in diagnosis and treatment, that its separate study has also become essential. Neither can we altogether neglect geology and meteorology, since conditions of soil and atmosphere are now recognized as important factors in the causation and relief of suffering.

It is scarcely necessary to insist on a knowledge of those sciences which are called "biological." *Anatomy* and *Histology*, formerly the mere handmaids of medicine, but now recognized as sciences worthy of independent study, are as necessary to us as is a chart to the navigator; while *Physiology*, which teaches us the use and mode of action of the anatomical and histological elements, is the medical practitioner.

Zoology and botany are not so absolutely necessary for us as are the other sciences, but it is evident that they are very necessary as preliminary studies for the biologist, to whom we look for instruction, for without a study of the simple forms and conditions of life a proper understanding of human anatomy and physiology is not attainable, and in so far as they teach us the conditions of existence of the various vegetable and animal parasites which affect the human body, from micrococci upwards, they are necessary for us as *surgeons and physicians*. This list of sciences is truly formidable, but I nevertheless assert that there can be no true study of medicine without a knowledge of the principles of all of them; and, for my own part, I have never had any difficulty, as a teacher of clinical medicine, in discriminating easily, by a perusal of their clinical reports, between those students who have, and those who have not, had an insight into the principles of pure science.

Scientific principles are to the physician and surgeon what the sextant and compass are to the navigator. Without them he cannot rise above the rank of a lighterman or a ferryman, but must be content to remain a mere "pill-monger," or a surgeon of a base mechanic sort. With them he may fearlessly launch his bark upon unknown seas, and may have the good fortune to extend the frontiers of science, or discover, as it were, new continents, to give a wider scope to the art which he professes.

To the medical man who would reap the advantages held out by Dr. Poore, *we confidently suggest the value of this journal* as a means of accomplishing the ends desired, at the least cost, and most convenient form. The impecunious can thus avoid the purchase of the mass of scientific literature with which the market is flooded, and the overworked practitioner receiving the journal weekly is not embarrassed by redundancy, and yet can safely rely on passing nothing of importance, while articles of special interest to the profession will be constantly brought before his notice.

In the previous numbers of "SCIENCE" may be found valuable articles by Professors Burt G. Wilder and Sage, of Cornell; Drs. Hammond and Spitzka, of New York; Dr. Clemenger, of Chicago; Dr. J. A. Mason, of Newport, and many other specialists of equal merit.

Now the value of a knowledge of science, as a means of "getting on" as Huxley terms it, is indubitable, and while there are few trades in which some knowledge of *science* may not be profitably applied to the pursuer of his occupation, we think that the words of Dr. Poore must carry conviction, that the *student* or Physician who would attain the higher stages of development of his art, must be kept "*au courant*" with such facts and principles, which are weekly published in "SCIENCE," for they will probably find their application in every intelligible diagnosis and discussion on medical practice.

"SCIENCE," November 5th, 1881.

WE learn with regret that Dr. Ed. C. Spitzka, who has been requested to appear in the Guiteau case, by both the Government prosecutor and counsel for the defence, has declined to attend.

The question of mal-practice is not likely to be seriously entertained at the trial, and the whole issue will probably rest upon the evidence touching the insanity of the prisoner.

We should judge from the published papers of Dr. Spitzka that his evidence would be in favor of the prisoner's insanity; it becomes, therefore, the more important that he should attend, as it would avoid the suspicion, in case of conviction, that the assassin had not received a fair trial.

NEW YORK ACADEMY OF SCIENCES.*

October 3, 1881.

REGULAR BUSINESS MEETING.

Vice-president Dr. B. N. Martin in the Chair.

Twenty-five members present.

After the transaction of business, the members were invited, in accordance with the usual custom at the first meeting of the season, to present notes and observations gathered during the summer, and responses were made by Mrs. E. A. Smith, Prof. C. A. Seeley, and others.

Mr. W. L. Chamberlain referred to the gold deposits recently opened in Fulton and Saratoga counties, N. Y. The ore consists of auriferous pyrites and is contained in the gneiss of the foothills of the Adirondacks.

Remarks were made, by a member, on a visit to the sandstone quarries at Portland, Conn.: by Mr. Todd, on a peculiar atmospheric phenomenon, a vaporous band stretching across the sky, apparently not auroral, observed in the Adirondacks: and by Dr. Martin, on a remarkable atmospheric coloration, luminous brilliance of the clouds, etc. observed last month at Saratoga, in the early morning, attributing it to an abundance of a smoky fog produced by the recent forest fires, and calling attention to the fact that this phenomenon has been noticed only in the territory east of the meridian of Saratoga.

Mrs. P. Hanaford described the same appearances as seen during the "Yellow Day" Sept. 6, near Boston, and also on Nantucket: another member, as seen in the Genesee valley, explaining that the strong West and Northwest winds prevailing at the time had wafted high in the air vast volumes of smoke derived from the abundant forest fires throughout Western N. Y.: Messrs. Todd, Chamberlain, and others, describing the electric brilliance of the gas-lights, the strange modification of the green color of foliage, the absence of smoky odor, etc., as observed at Great Barrington, Mass., and in less degree in New York city: Mr. N. L. Britton, on the same facts as observed out at sea, off Fire Island and Montauk Point, Long Island, N. Y.: Prof. D. S. Martin, as observed between Saratoga and Catskill, N. Y., and Prof. C. A. Seeley, calling attention to the extremely attenuated character of the carbon particles, produced by their long transportation from distant localities.

Mr. Geo. F. Kunz mentioned that Mt. Mica, at Paris, Maine, the locality so famous for colored Tourmalines for the last fifty years, had been purchased by a Mining Company and was being worked for Cassiterite, Mica and Tourmaline, principally through the efforts of Dr. A. C. Hamlin of Bangor, Maine.

Dr. Hamlin has the finest known collection of American Tourmaline, and he recently reported the finding of a crystal three inches long and one-half inch thick, a transparent gem, of a beautiful blue-green color. This was taken from the new mine, and many more remarkable specimens may be expected as the work advances.

Mr. Kunz said that during the last year a German Agate-hunter returned to his native country after 20 years collecting in Brazil, taking with him a large suite of fine colored Tourmalines, some five inches long and not more than one-eighth of an inch thick, transparent, and of a green color; also many fine green crystals with red, yellow, white, and other colored centres, many of these equalling for variety of color anything yet found, most of which will cut as gems. There is also in this lot one exceptionally fine green crystal over one inch square. This collector brought with him also at least 1000 kilos of transparent yellow Spodumene, the same as that described by A. Pisani of Paris some eighteen months ago, and is dissimilar only in color to the new variety of Spodumene found at Stony Point, North Carolina, described in the February number of the *American Journal of Science* for 1881, by Dr. J. Lawrence Smith, as Hiddenite. Some of the specimens which he brought will cut as fine yellow gems. All these were found in the Minas Geraes district. Recently a new locality for Chrysoberyl has been found in Ceylon, where they occur of gem value in an unusual variety of color. They vary in color from yellow to brown, and from brown to green. The latter color is the variety known as Alexandrite. This gem has heretofore been found but of very inferior size and color, but here it occurs of remarkable size, having in one case afforded a gem weighing 26 kts. They are a beautiful green color by day and a Columbine red, or brownish red, by night. The Chrysoberyl Cat's Eye is found here of the same color, and possessing the same dichroic property as the Alexandrite, viz., changing color, from green to red, and hence might very properly be called an Alexandrite Cat's Eye. Many of the Chrysoberyls are erroneously called and sold as a variety of sapphire.

* Official Report.

SECTION OF CHEMISTRY.

October 10, 1881.

Vice-president Dr. B. N. Martin in the Chair.

Nineteen members present.

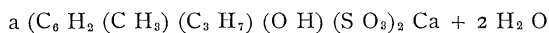
A paper was read by Mr. James H. Stebbins, Jr., of which the following is an abstract :

ON SOME NEW SALTS OF THYMOL SULPHO-ACID, AND SOME NEW FACTS CONCERNING THE SAME.

60 grms. thymole were dissolved in 50 grms. 66° sulphuric, at a temperature of 100 C. The pink crystalline mass so obtained was dissolved in water, and converted into the lime salt.

This salt crystallizes with two molecules of water, in rhombic plates, and shows under the polariscope a beautiful effect of circular polarized light.

FORMULA.

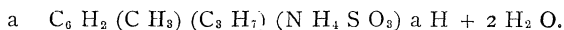


α . Calcium salt of alpha thymole sulpho-acid.

AMMONIUM SALT.

This salt was obtained by decomposing the lime salt, with ammoniac carbonate. It crystallizes in white rhombic plates, with 2 mols. of water.

FORMULA.



The soda salt has likewise been obtained, and will be described in a subsequent paper.

Remarks were made by Mr. James D. Warner on the nature of the corona of the Sun, etc. Mr. Stebbins reported the yellow coloration of the atmosphere in September at the Thousand Islands in the St. Lawrence.

SECTION OF GEOLOGY AND MINERALOGY.

October 17, 1881.

The President, Dr. J. S. Newberry, in the Chair.

Fifty-one persons present.

Dr. Newberry exhibited specimens of Native Lead and Oxide of Lead from a mine in the Wood River country, Idaho, crystallized gray copper, and fine crystallized Rhodochrosite from the Ulay mines, Southwest Colorado.

Prof. T. Egleson pronounced the crystals of rhodochrosite to be the finest specimens ever yet found. He further called attention to the discovery of the presence of tellurium in merchant copper from Lake Superior. This curious specimen of native copper pig was found to contain about 0.5 per cent. of that element, which has never yet been detected in the copper. In the furnace the pig yields dense white fumes; it is useless for brass, etc., and only fit for the manufacture of cupric sulphate for batteries. With the tellurium are associated a little silver and gold, which are found not to be uniformly distributed, as hitherto supposed, but so variably that the proportion of silver varies widely in portions taken from the furnace within ten minutes of each other.

Dr. J. S. Newberry then remarked on "Geological Facts recently observed in Montana, Idaho, Utah and Colorado."

Idaho and Montana.—The famous placers at Helena and Virginia, which have yielded thirty millions of dollars, are now exhausted, but vein-mining is in successful progress and yielding rich results at Butte, at the Alice, Lexington, Copper Bell, and other mines. These are true fissure veins, traversing a granite forma-

tion, and the speaker predicted their abundant yield of silver and copper twenty years hence. These territories have been simply crossed by two government expeditions and their resources have not been at all studied. It is the coming mining region, more discoveries of promising mines having been recently made here than in any other portion of the country. On the east of the mountains in Montana and Wyoming lies a fine agricultural country and excellent stock range, the herds ranging freely throughout the winters, in spite of their severity, with little loss, and grazing upon a native bunch-grass (*Festuca scabrella*) and the buffalo grass (*Buchloe dactyloides*). The climate is salubrious, the country very beautiful in many parts and very promising for emigration. In the adjacent Rocky Mountain range there are also many mining opportunities.

The remarkable lava plain, 400 miles long by 75 miles wide, in Central Idaho, was then described.

Snake River, one of the chief tributaries of the Columbia, flows along its southern border for several hundred miles; its northern tributaries sinking under the lava sheet and flowing in subterranean channels 50 or 60 miles long. The rock is a basalt said to contain everywhere a small quantity of gold and silver. It is generally covered with an impalpable soil that produces a dust excessively annoying to the traveler, and sustains a general growth of sage brush. In places, however, the rock is bare and looks like a congealed stormy sea.

Three buttes are set on the surface of this lava plain, and each has probably been a local volcanic vent; but it is probable that most of this eruptive material has been an overflow from great fissures of which the position is not indicated on the surface.

Snake River crosses a portion of this plain in a cañon at the head of which are the great Shoshone Falls, 208 feet in vertical altitude.

An alluvial plain borders Snake River for 200 miles, abounding in black sand which contains much gold. This is, however, extremely fine, having been transported a long distance from its place or origin, and therefore difficult of separation. New and promising methods and machines are about to be tried in the exploitation of these extensive deposits. A wide mountain belt extends from the north side of the lava plain to and beyond the British line, and is apparently a good mining country throughout. Already a great number of productive and promising mines are opened in the southern portion of this belt. In the Wood River district the veins are not large, but numerous, regular and persistent, and the ore of high grade—mostly argentiferous galena, carrying \$100 to \$500 in silver to the ton. Near Challis, further north, is the celebrated Ram's Horn mine, located on a true fissure vein, generally not more than five feet wide, but continuous for more than five miles. The wall rocks are slate, the vein stone siderite (carbonate of iron), the ore gray and yellow copper, yielding \$100 to \$1200 in silver to the ton. A few miles west of Challis is the mining town of Bonanza, where are located the celebrated Charles Dickens and Custer mines, carrying both silver and gold. Still further west in the Saw-Tooth range, a high and very picturesque mountain chain running north and south, recent discoveries of valuable mines have been made. From this district north to the Canadian line, a broad mountain belt extends over northern Idaho and northwestern Montana, a country which abounds in veins of silver, copper and gold. Among the mines now worked in this region the most celebrated is the Drum Lomond, in Montana. It is opened on a large vein of rich quartz and is owned by an old miner who cannot read, but who is said to have refused a million of dollars for the property. It is probably worth much more than this.

Most of the mountainous districts of Idaho and Montana are covered with coniferous forests, consisting of the Douglas spruce and the northern nut pine, *Pinus*

flexilis. The smaller plants form an Alpine flora of much interest, including many beautiful flowering species; perhaps the most striking being *Bryanthus*, which has a fine fir-like foliage and clusters of beautiful purple flowers. It belongs to the heath family and closely resembles the heather of Scotland.

The streams of this region are clear, cold, and rapid, and abound in fish, chiefly of the salmon family, and these have given the name to Salmon River, the principal water course.

Two species of salmon were running up the Salmon River, one the large Quinnet or Chinook salmon, comparatively rare, and the other the "red fish" (*Oncorhynchus nerka*). This is a small salmon, 15 to 18 inches in length, and weighing 3 to 5 pounds. As seen in their migration their bodies are brick red to purple in color, the heads dark or light green; they were then going up to their spawning ground, Redfish Lake, one of a half dozen of small lakes on the head waters of the Columbia, which are the special breeding places of this interesting fish. Coming all the way from their abode in the ocean, led by an infallible but inscrutable instinct, they push on night and day till they reach their remote birthplaces in these little lakes far up in the mountains and 1000 miles from their starting point. Here they accomplish apparently the great object of their lives, the reproduction of the species, by depositing the spawn in the shallows of the rivulets which fall into the lake.

The always attractive coloring of the fish, during this nuptial season becomes greatly heightened; the body assumes a brilliant, almost luminous red, as bright as that of the gold fish, and where numbers are dashing through the water literally in a blaze of excitement, they produce an exhibition that is strikingly novel and interesting.

When the spawning season is over they probably do not return, as none are seen descending the rivers. The young fish start on their migration to the ocean while yet very small, and within the first year of their lives, remaining away it is supposed some three or four years during which they acquire their full growth when they return to die where they were born.

An active industry has grown up in the capture of the red fish in their annual migrations, but it is pushed with so much energy and unsparing cupidity that their numbers are rapidly diminishing and the species will apparently be soon extirpated in these waters unless protected by legal enactment.

A branch of the Union Pacific Railroad is being constructed from Granger, Wyoming, to the mouth of the Columbia. On this a large amount of traffic is expected, as it will link together many settlements having a considerable resident population and traverse in different portions of the route rich agricultural and mining districts.

Dr. Newberry then briefly described a small but remarkably rich placer gold deposit he visited on the west flank of Mount Wheeler, the highest mountain in Nevada, and mentioned the discovery of an outcrop of lower silurian rocks full of fossils, including several new trilobites discovered by him in Southwestern Utah, but deferred all details till he should make them the subjects of special remark to the Academy.

Colorado.—Reference was made to the general character of Southwestern Colorado, the interesting topography of the region, especially the vast plateau which rises westward from the base of the Rocky Mountains on to the slopes of the Wasatch; the ascent of Marshall's Pass by the Denver and Rio Grande Railroad, the most remarkable feat of railroad engineering performed in the country, and the exceedingly picturesque region about the Pagosa the greatest hot spring on the continent. Where the San Juan river issues from the mountains a prairie occurs, surrounded by picturesque forest-clad hills, and with a beautiful view of snow-clad mountains in the distance. In the centre of the prairie lies a basin 40 by 60 feet across, boiling like a huge caldron, the ebullition being

produced by the violent escape of carbonic acid gas. The banks are lined by the remains of beetles, snakes, etc., destroyed by too trustful reliance upon the hot waters, and by interesting mineral deposits. This is one of the most beautiful places in the country and likely to be a famous resort.

Along the route from Pueblo to Gunnison and Lake City, and thence eastward by Del Norte, there are some places of resort for invalids and pleasure-seekers, which are destined to be very well known, being far more beautiful and salubrious than the now celebrated localities at Manitou and Colorado Springs. One of these is Wagon Wheel Gap, on the Rio Grande. The river is a rapid, turbulent stream, and the Gap is seven to ten miles long, just wide enough to permit a wagon-road. Then a wide, open space is reached, the basin of an ancient lake, girdled by a wonderfully beautiful amphitheatre of mountains. Here 8500 feet above the sea, the hot springs, charming rides, fine hunting and fishing, an atmosphere as pure and clear as crystal, constitute the attractions of a resort, which far surpasses any other, and which will be reached by the railroad now being pushed through the Gap about January 1, 1882.

From Gunnison, specimens have been recently brought of magnetite and hematite, which probably represent inexhaustible masses, and at Crested Butte, within twenty-five miles of this locality, is found the best coking coal in the West. The region borders on a volcanic area, and the coking coal is from that portion of the basin, which has mostly escaped the alteration by volcanic heat. It is firm and not affected by the weather, with a small amount of ash and sulphur.

On Anthracite Creek are found many thousand acres of Anthracite of better quality than that of Pennsylvania. Recent analysis made at the School of Mines shows it to contain less than one per cent. of sulphur, and three per cent. of ash.

The forest vegetation of Colorado is very simple. The piñon or nut pine is very common, also the yellow pine (*P. ponderosa*), Douglas' spruce, Menzies' spruce, etc. In the mountains the general vegetation is picturesque but not so varied as in the lowlands. The following plants are among the most characteristic in the lowlands of Colorado and Utah.

The evening primrose (*Oenothera Caespitosa*) with its large beautiful white flowers.

The wild tobacco (*Nicotiana attenuata*.)

The sun flower (*Helianthus*.)

The bee flower (*Cleome integrifolia*) presenting purple acres by the roadside, and the yellow species (*C. lutea*) less common.

The American primrose (*Primula Parryi*.)

The pasque flower (*Anemone patens*, *Var. Nuttalliana*.)

The *Eriogonums*, about twenty species, coloring whole mountain sides yellow.

The Oregon grape (*Berberis aquifolium*.)

Phacelia circinata in tufts of purple flowers on rocky slopes.

The lily (*Calochortus Gunnisoni* and *C. Nuttalli*) or "blackeyed Susan" (Indian—"Seego,") very plenty in the moister portion of the sage-plains.

The clematis (*Anemone alpina*) with its purple flowers.

The penstemons, of which 20 or 30 species are peculiar to that country, deep crimson, pink, and purple and blue in color, often very showy, and so abundant that whole acres of ground are colored by them.

The columbine (*Aquilegia canadensis*.) and also a much larger species (*A. cerulea*.) clothing the mountains of Colorado and Utah, with blue, cream-colored, and white flowers. A large number of dried plants were exhibited from a collection of several hundred species just brought on from Colorado, with collections procured from Prof. Marcus Jones of Salt Lake City, and others.

RETARDED DEVELOPMENT IN INSECTS.*

By C. V. RILEY, Washington, D. C.

In this paper the author records several interesting cases of retarded development in insects, whether as summer coma or dormancy of a certain portion of a given brood of caterpillars, the belated issues of certain imagines from the pupa, or the deferred hatching of eggs. One of the most remarkable cases of this last to which he calls attention, is the hatching this year of the eggs of the Rocky Mountain Locust, or Western Grasshopper (*Caloptenus spretus*), that were laid in 1876, around the Agricultural College at Manhattan, Kansas. These eggs were buried some ten inches below the surface, in the Fall of 1876, in grading the ground around the chemical laboratory. The superincumbent material was clay, old mortar and bits of stone, and a plank sidewalk was laid above all. In removing and regrading the soil last spring Mr. J. D. Graham noticed that the eggs looked sound and fresh, and they readily hatched upon exposure to normal influences, the species being determined by Prof. Riley from specimens submitted by Mr. Graham. Remarkable as the facts are there can be no question as to their accuracy, so that the eggs actually remained unhatched during nearly four years and a half, or four years longer than is their wont, and this suggests the significant question: How much longer could the eggs of this species, under favoring conditions of dryness and reduced temperature, retain their vitality and power of hatching?

Putting all the facts together Mr. Riley concludes that we are as yet absolutely incapable of offering any satisfactory explanation, based on experiment, of the causes which induce exceptional retardation in development among insects. It is a very general rule that a rising temperature stimulates and accelerates growth, while a falling temperature retards and torpifies, and experiments recorded by the author* show that such is the case with regard to the eggs of *Caloptenus spretus*. But there are many exceptions to the rule. The eggs of Crustaceans, as *Apus* and *Cypres*, are known to have the power of resisting drought for six, ten or more years without losing vitality, while in some cases they seem actually to require a certain amount of desiccation before they will hatch. Yet the fact remains that different act differently in this respect. In short, nothing is more patent to the observing naturalist than that species, and, even individuals of the same species, or the progeny of one and the same individual, act very differently under like external conditions of existence; or in other words, that temperature, moisture, food, etc., influence them differently. Hence—as has been shown by Semper to be the case with other animals, so it is with insects—changes in the external conditions of existence will not affect the fauna as a whole equally, but will act on individuals. We can understand how this great latitude in susceptibility to like conditions may and does, in the case of exceptional seasons, prove beneficial to the species by preserving the exceptional individuals that display the power to resist the unusual change; but we shall find ourselves baffled when we come to seek a demonstrable explanation of the cause or causes of such retardation, while the principles of evolution afford us the only hypothetical one at all satisfactory. In the innate property of organism to vary, and in the complex phenomena of heredity, we get a glimpse at the cause—a partial explanation—of the facts of retarded development; for the exceptional tendency in the present may be looked upon as a manifestation through atavism of traits which in the past had been more commonly possessed and more essential to the species.

*—Abstract of a paper read before the Entomological Section of the A. A. A. S., at Cincinnati.

*—9th Rep. Ins. Mo., also 1st Rep., U. S. Entomological Commission.

ON THE "LIFE DURATION OF THE HETEROCERA (MOTHS *)."

(Abstract.)

By J. A. LINTNER, State Entomologist of New York.

The subject of life duration of our insects, not having been given special study, so little is known upon it, that the present contribution would not be warranted, were it not that the confession of our ignorance upon the point, may serve as an incentive to its examination.

It is a difficult field of study, for the observations should be made upon the insects in the natural conditions—not in confinement. Even of the latter state, our knowledge is quite limited. Entire broods of species have seldom been reared, except in the Bombycidae and Sphingidae, where the eggs are easily to be obtained. But in the large family of Noctuidae, I do not know that an entire oviposition, or even a considerable part of one, has ever been carried through to the perfect stage, nor have I any personal knowledge of the time, place, manner or duration of copulation among them.

In the Attacinae of the Bombycidae, the lives of most are brief; that of the female seldom reaches fifteen days, while in the male it is still shorter. It is longer in the Sphingidae.

We may best obtain an approximation to the life period of the moths, from reference to the dates when they are observed abroad. The lists published of collections "at sugar," furnish us with the best data. From a list prepared by myself, it appears that a large number of species of Noctuidae were abroad for about one month. Deducting one-third of this time for their probable unequal emergence from the pupae, there would remain a term of three weeks for their approximate life duration.

Mr. W. L. Devereaux, of Clyde, N. Y., from his observations, also infers, "that most of the species remain for about a month."

As would be expected from so heterogeneous a family as the Noctuidae, the different groups present different life periods. The genera *Xylina*, *Homoptera* and *Catocala*, are found to have a considerably longer continuance than that above given. Three species of *Xylina* were observed by me for forty-one, forty-seven and fifty-one days; ten species of *Catocala*, for an average of forty-five days; and nine species of the same genus, as reported by Mr. Devereaux, for fifty-seven days.

In view of the benefits which would result to Entomology, it is suggested, that in future lists published of our insects, the different dates at which they are observed throughout the year, be included. It would aid us in determining life duration—would indicate the time when to guard against the commencement of insect attack—when to commit our crops to the ground—when to search for specimens for our cabinets—in short, it would furnish an essential part of the life histories of our species.

MR. G. FASOLDT says, in a letter to the *American Journal of Microscopy*:—

I have ruled plates up to 1,000,000 lines to the inch, one of which was purchased by the United States Government at Washington.

These plates show lines truly and fairly ruled, as far as lenses are able to resolve, and above this point the spectral appearance of the bands in regular succeeding colors (when examined as an opaque object) shows, beyond doubt, that each band contains fairly ruled lines up to the 1,000,000 band.

I do not believe that I will ever attempt to rule higher than 1,000,000 lines per inch, as from my practical experience and judgment, I have concluded that that is the limit of ruling.

* Read before the A. A. A. S., Cincinnati, 1881.

ELECTRIC RAILROADS IN PARIS.

The visitors at the Electrical Exhibition can see a very fine model in bronze, surmounted by very beautiful designs, which represents an electric elevated railroad. This model is placed in the large aisle very near the pavilion of the City of Paris. It is in miniature a part of the new system of railroads which should be constructed over all the great streets of the capital in order to lessen the number of encumbrances and to supply the want of locomotive means of which the whole city justly complains. M. J. Chrétien, the inventor of the new system, proposes its immediate application to all the great boulevards.

Electricity has indisputable advantages over other methods of locomotion. It is an economic method which can produce very slow as well as very rapid motion, which causes no noise or smoke, and which only allows the use of light vehicles and, consequently, the laying of unobstructive tracks. The building of electric railroads in places where business is most active, will have the double result of freeing the public roads of obstructions and of giving to the public sufficient means of transportation.

The following details we borrow from a pamphlet published by M. J. Chrétien entitled "Chemin de fer électrique des boulevards." The electric road is a double-

railed viaduct supported by a row of columns spaced about forty or fifty metres from each other, and placed in the middle of the road. A central hollow beam rests on the columns and carries all the load; it runs the whole length of the boulevard, at a height varying from five to seven metres above the earth in order to compensate for the irregularities of the ground. On each side of the beam the rails are placed, resting on a metallic platform, so that there is one on the right and another on the left.

The stations, twelve in number, are placed about 500 metres from each other, and we can ascend by a very convenient staircase, placed either over the sidewalk or over the pavement. For the station most elevated above the ground, electric elevators are provided for the use of those who wish to ascend. It can even be said that it is easier to take the electric road than to ride in an omnibus.

Two works for the supply of the motive force are placed under the ground. Each of these works consists of steam engines to furnish the motive force and Gramme dynamo-electric machines to produce the electric currents, when they are set in motion by the steam engines.

The electricity thus produced is transmitted through the whole length of the road by conducting wires, and distributed to the various carriages. These are put in motion by means of electric machines, which each of them carries, and which receive, through the conducting wires, the electricity necessary to attain the speed required.

Thanks to very simple means, applications of electricity, there can be no collisions, no accidents of any kind; the motions are easier than in the ordinary railroad, and the carriages can regulate their speed with remarkable precision.

The speed is about 350 to 400 metres a minute, that is to say, the speed of a good trotting horse; with this speed, and reckoning a half minute for the mean time of stop-

page at station, the whole length of the road, which is 4500 metres, can be traversed in about 17 or 18 minutes. This is half the time of an ordinary omnibus.

According to the ideas which we draw from the pamphlet spoken of, the capacity for transportation of the electric road is so great, that we with some difficulty accept the given figures, while it is easy to try the exactness of them. Thus, every minute a carriage, with places for 50, passes each station; so that, if the carriages are always full, there will be 100 persons carried each minute in the two directions, and if we take account of the additions during the journey, we will have about twice as much; that is about 200 persons every minute, or 12000 per hour. But it is possible to still increase the carrying capacity, and to reach the maximum corresponding to the trip of two carriages joined together, at intervals of a minute. We will arrive, in this case, to the colossal figure of 24000 persons an hour. Although these figures appear more than sufficient, it is certain, for those who know the activity at certain times upon the boulevards, that there are times when everybody cannot find room without waiting.

From the given estimate, the total expense necessary for the construction of the road, will only be from eight to ten millions, according to the greater or less magnificence necessary to construct a work of this importance in the centre of such a city as Paris.

Assuming an expense of eight millions, it is calculated that the price of a seat can be fixed at ten centimes, to realize profits large enough to pay the city an annual revenue of a million or a million and a half, without asking any subsidy whatever. The electric road has then as its several results, the furnishing the means of an agreeable, easy and economic locomotion, the satisfying the demands of a great traffic, which is growing day by day, and the supplying of an important revenue to the city, while still the price of a seat is kept at ten centimes.

In regard to the appearance of the road, which has a great importance in such a city as Paris, where art has never been too much sacrificed, it will certainly be seen, after a careful examination of the given designs and the engravings, that it is possible to give an artistic character to this work. Such as it is represented, the elevated road lacks neither strength nor magnificence; it is in the modern style, which alone is becoming to a work which our ancestors never dreamed of. It has been suggested besides, that, in order to fully satisfy the artistic demands, a competition should be opened to all architects and artists; and this would certainly lead to excellent results.

The utility and advantage of the electric road cannot be disputed; that it should exist is obvious, and the proposed work leaves nothing to be desired. This splendid work will certainly be accomplished, but perseverance and labor are necessary in order to vanquish all resistance, routine, and inertia, against which it would otherwise be fatally injured.—*Translated from La Nature.*

CHLORAL HYDRATE IN TOOTHACHE.—Dr. Spörer recommends that three to four lumps of hydrate of chloral (0.03–0.06 gram), should be inserted into the hollow and painful tooth, the chloral being allowed to dissolve.—*St. Petersburg, Med. Wochenschrift.*

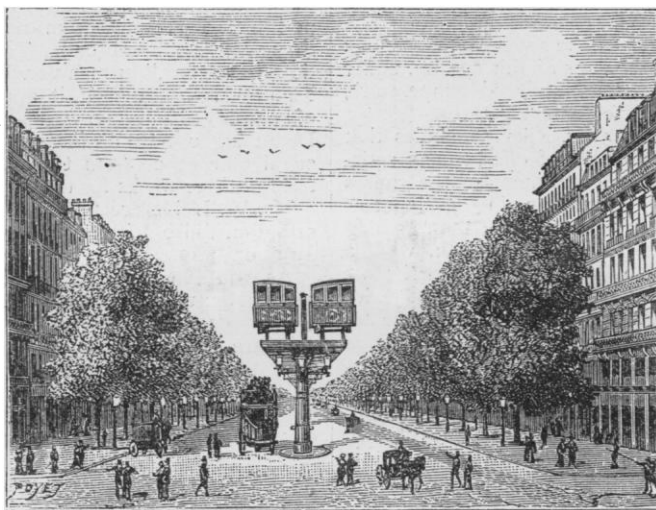


Fig. 3.—SECTION OF THE PROPOSED ROAD.

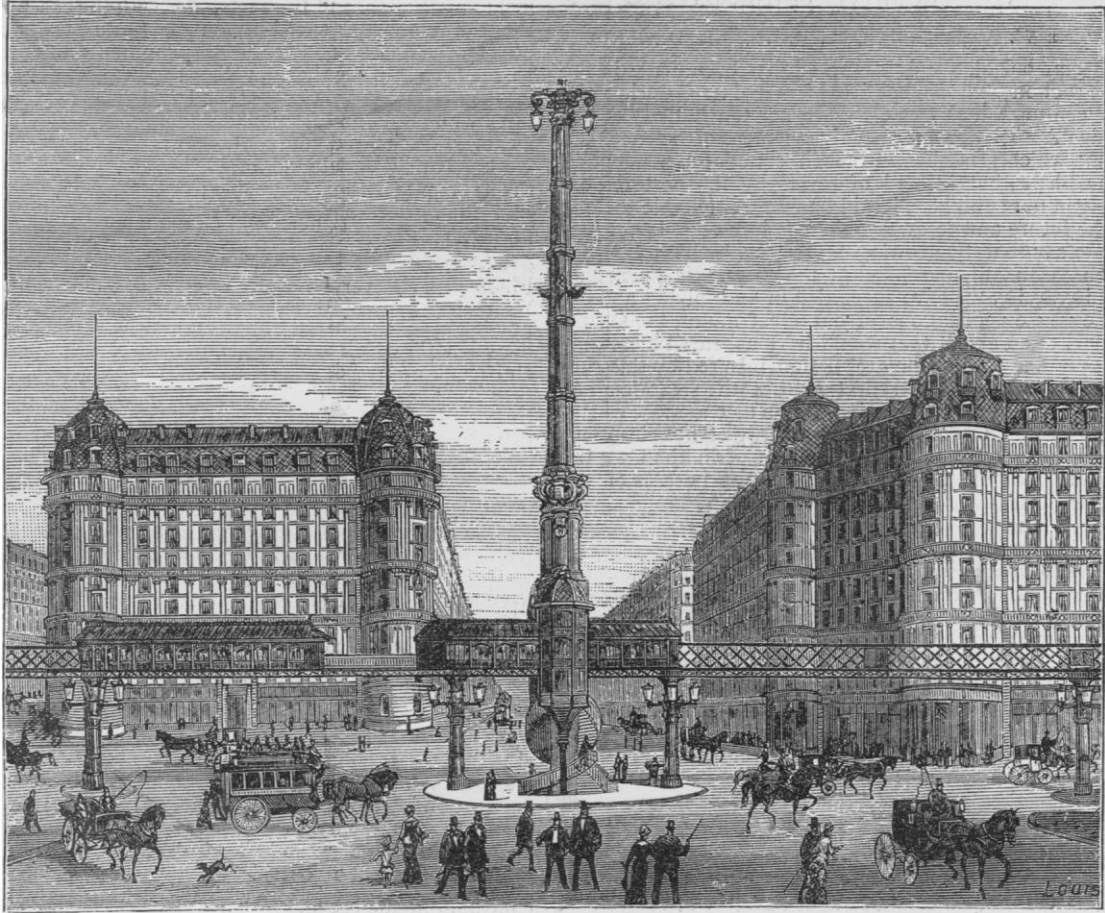


FIG. 1. ELECTRIC ELEVATED RAILROAD FOR THE BOULEVARDS OF PARIS. PLAN OF M. CHRÉTIEN. VIEW OF A STATION.

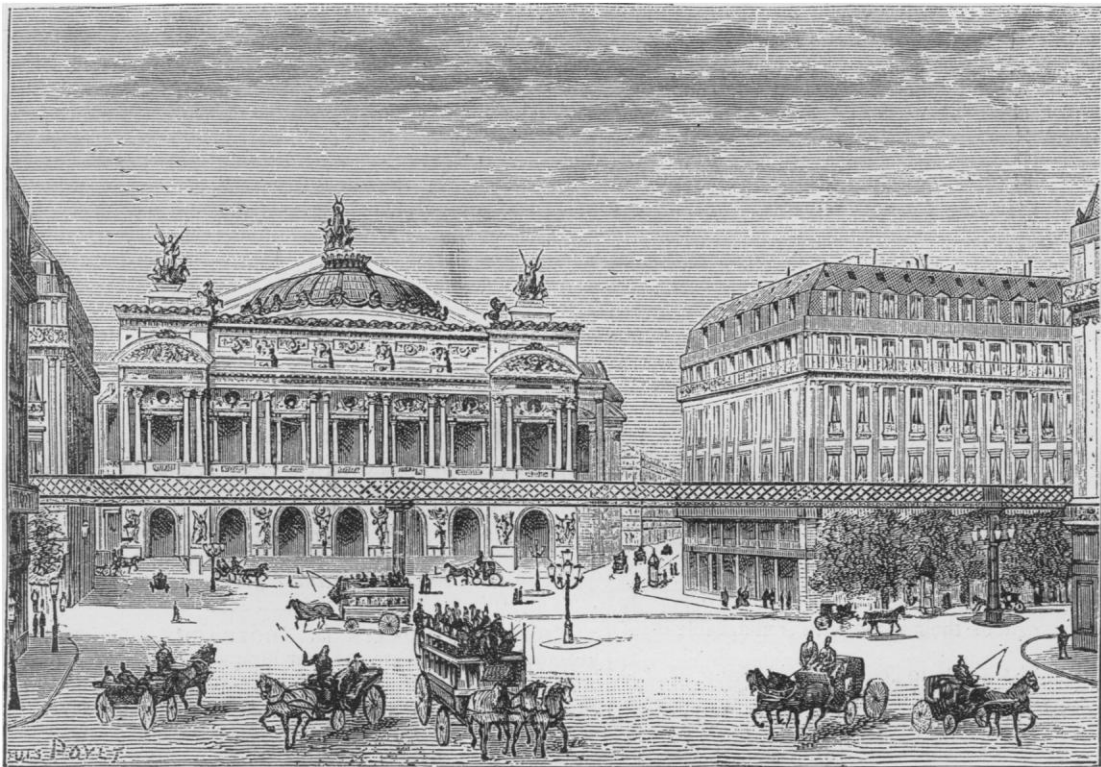


FIG. 2. PLAN OF THE ELECTRIC ELEVATED ROAD. VIEW BEFORE THE GRAND OPERA OF PARIS.

MECHANICAL SCIENCE*

BY SIR W. ARMSTRONG, C.B., D.C.L., LL. D., F.R.S.

The astonishing progress which has been made in the construction and application of machinery during the half century which has elapsed since the nativity of the British Association for the Advancement of Science, is a theme which I might with much complacency adopt in this address, but instead of reviewing the past and exulting in our successes, it will be more profitable to look to the future and to dwell on our failures. It is but justice to say that by growing experience, by increasing facilities of manufacture, and by the exercise of much skill and ingenuity, we have succeeded in multiplying and expanding the applications of our chief motor, the steam-engine, to an extent that would have appeared incredible fifty years ago; but the gratulation inspired by this success is clouded by the reflection that the steam-engine, even in its best form, remains to this day a most wasteful apparatus for converting the energy of heat into motive power. Our predecessors of that period had not the advantage of the knowledge which we possess of the true nature of heat, and the conditions and limits affecting its utilization. In their time heat was almost universally regarded as a fluid which, under the name of caloric, was supposed to lie dormant in the interstices of matter until forced out by chemical or mechanical means. Although Bacon, Newton, Cavendish, and Boyle all maintained that heat was only internal motion, and although Davy and Rumford not only held that view, but proved its accuracy by experiment, yet the old notion of caloric continued to hold its ground, until in more recent times Joule, Meyer, Codrington, and others, put an end to all doubt on the subject, and established the all-important fact that heat is a mode of motion having, like any other kind of motion, its exact equivalent in terms of work. By their reasonings and experiments it has been definitely proved that the quantity of heat which raises the temperature of a pound of water 1° Fahrenheit, has a mechanical value equal to lifting 772 lbs. one foot high, and that conversely the descent of that weight from that height is capable of exactly reproducing the heat expended.

The mechanical theory of heat is now universally accepted, although a remnant of the old doctrine is displayed in the continued use of the misleading term "latent heat." According to the new theory, heat is an internal motion of molecules capable of being communicated from the molecules of one body to those of another, the result of the imparted motion being either an increase of temperature, or the performance of work. The work may be either external, as where heat, in expanding a gas, pushes away a resisting body, or it may be internal, as where heat pulls asunder the cohering particles of ice in the process of liquefaction, or it may be partly internal and partly external, as it is in the steam engine, where the first effect of the heat is to separate the particles of water into vapor, and the second to give motion to the piston. Internal as well as external work may be reconverted into heat, but until the reversion takes place, the heat which did the work does not exist as heat, and it is delusive to call it "latent heat." All heat problems are comprised under the three leading ideas of internal work, external work, and temperature, and no phraseology should be used that conflicts with those ideas.

The modern theory of heat has thrown new light upon the theory of the steam-engine. We now know what is the mechanical value in foot pounds of the heat evolved in the combustion of one pound of coal. In practice we can determine how much of that heat is transmitted to the water in the boiler, and we are taught how to calculate the quantity which in the process of vaporisation takes the form of internal work. We can determine how much disappears in the engine in the shape of external work,

including friction, and the remainder, with the exception of the trifling quantity saved in the feed-water, we know to be lost. Taking a good condensing engine as an example, we may roughly say that, dividing the whole heat energy into ten equal parts, two escape by the chimney, one is lost by radiation and friction, six remain unused when the steam is discharged, and only one is realized in useful work. It may be fully admitted that the greater part of the aggregate loss is inevitable; but are we to suppose that the resources of science, ingenuity, and skill have been exhausted in the attainment of so miserable a result? Nothing but radical changes can be expected to produce any great mitigation of the present monstrous waste, and without presuming to say what measures are practicable and what are not, I will briefly point out the directions in which amelioration is theoretically possible, and shall afterwards advert to the question whether we may hope to evade the difficulties of the steam-engine by resorting to electrical methods of obtaining power.

To begin with the loss which takes place in the application of heat to the boiler; why is it that we have to throw away, at the very outset of our operations, twice as much heat as we succeed in utilizing in the engine? The answer is, that in order to force a transmission of heat from the fire to the water in the boiler, a certain excess of temperature over that of the water must exist in the furnace and flues, and the whole of the heat below the required excess must pass away unused, except the trifling portion of it which disappears in the production of draught. Further, that since we cannot avoid admitting the nitrogen of the air along with the oxygen, we have to heat a large volume of neutral gas which has no other effect than to rob the fire. Considering what efforts have been made to facilitate the transmission of the heat by augmenting the evaporative surface, and using thin tubes as flues, it is vain to expect any great result from further perseverance in that direction, and unless a method can be devised of burning the fuel inside instead of outside the apparatus, so as to use the heated gases conjointly with the steam as a working medium in the engine, a remedy appears to be hopeless. We already practice internal combustion in the gas-engine, and it is clear that with gaseous fuel, at all events, we could associate such a mode of combustion with the vaporization of water. We may even regard a gun as an engine with internally-burnt fuel, and here I may remark that the action of heat in a gun is strictly analogous to that of heat in a steam-engine. In both cases the heat is evolved from chemical combination, and the resulting pressures differ only in degree. The gun is the equivalent of the cylinder, and the shot of the piston, and the diagrams representing the pressure exerted in the two cases bears a close resemblance to each other. While the powder is burning in the gun we have a nearly uniform pressure, just as we have in the cylinder while the steam is entering, and in both cases the uniform pressure is followed by a diminishing pressure, represented by the usual curve of expansion. If in the steam-engine we allowed the piston to be blown out it would act as a projectile, and if in the gun we oppose mechanical resistance to the shot, we might utilize the effect in a quieter form of motive power. But it is a remarkable fact that such is the richness of coal as a store of mechanical energy that a pound of coal, even as used in the steam-engine, produces a dynamic effect about five times greater than a pound of gunpowder burnt in a gun. I cannot, however, on this account encourage the idea that steam may be advantageously substituted for gunpowder in the practice of gunnery.

And now to turn from the fire which is the birthplace of the motive energy, let us follow it in the steam, to the condenser, where most of it finds a premature tomb. From the point at which expansion commences in the cylinder the temperature and pressure of the steam begin to run down, and if we could continue to expand indefi-

*British Association, 1881.

nately, the entire heat would be exhausted, and the energy previously expended in separating the water into steam would be wholly given up in external effect; but this exhaustion would not be complete until the absolute zero of temperature was reached (*viz.*, 461° below the zero of Fahrenheit). I do not mean to say that an ideally perfect engine necessarily involves unlimited expansion, seeing that if instead of discharging the steam at the end of a given expansion, we made the engine itself do work in compressing it, we might, under the conditions of Carnot's reversible cycle so justly celebrated as the foundation of the theory of the steam-engine, recommence the action with all the unutilized heat in an available form. But an engine upon this principle could only give an amount of useful effect corresponding to the difference between the whole work done by the engine, and that very large portion of it expended in the operation of compression, and this difference viewed in relation to the necessary size of the engine, would be quite insignificant, and would in fact be wholly swallowed up in friction. Carnot did not intend to suggest a real engine, and his hypothesis therefore takes no cognizance of losses incident to the application of an actual fire to an actual boiler. His ideal engine is also supposed to be frictionless, and impervious to heat except at the point where heat has to be transmitted to the water, and there the condition of perfect conduction is assumed. In short an engine which would even approximately conform to the conditions of Carnot's cycle is an impossibility, and a perfect steam-engine is alike a phantom whether it be sought for in the cyclical process of Carnot, or under the condition of indefinite expansion. Practically we have to deal with a machine which, like all other machines, is subject to friction, and in expanding the steam we quickly arrive at a point at which the reduced pressure on the piston is so little in excess of the friction of the machine as to render the steam not worth retaining, and at this point we reject it. In figurative language we take the cream off the bowl and throw away the milk. We do save a little by heating the feed water, but this gain is very small in comparison with the whole loss. What happens in the condenser is, that all the remaining energy which has taken the form of internal work is reconverted into heat, but it is heat of so low a grade that we cannot apply it to the vaporization of water. But although the heat is too low to vaporize water it is not too low to vaporize ether. If instead of condensing by the external application of water we did so by the similar application of ether, as proposed and practised by M. du Trembley twenty-five years ago, the ether would be vaporized, and we should be able to start afresh with high tension vapor, which in its turn would be expanded until the frictional limit was again reached. At that point the ether would have to be condensed by the outward application of cold water and pumped back, in the liquid state, to act over again in a similar manner. This method of working was extensively tried in France when introduced by M. du Trembley, and the results were sufficiently encouraging to justify a resumption of the trials at the present time, when they could be made under much more favorable conditions. There was no question as to the economy effected, but in the discussions which took place on the subject it was contended that equally good results might be attained by improved applications of the steam, without resorting to an additional medium. The compound engine of the present day does in fact equal the efficiency of Du Trembley's combined steam and ether-engine, but there is no reason why the ether apparatus should not confer the same advantage on the modern engine that attended its application to the older form. The objections to its use are purely of a practical nature, and might very possibly yield to persevering efforts at removal.

I need scarcely notice the advantage to be derived from increasing the initial pressure of the steam so as to

widen the range of expansion by raising the upper limit of temperature instead of reducing the lower one. It must be remembered, however, that an increase of temperature is attended with the serious drawback of increasing the quantity of heat carried off by the gases from the fire, and also the loss by radiation, so that we have not so much to gain by increase of pressure as is commonly imagined.

But even supposing the steam-engine to be improved to the utmost extent that practical considerations give us reasons to hope for, we should still have to adjudge it a wasteful though a valuable servant. Nor does there appear to be any prospect of substituting with advantage any other form of thermodynamic engine, and thus we are led to inquire whether any other kind of energy is likely to serve us better than heat, for motive power.

Most people, especially those who are least competent to judge, look to electricity as the coming panacea for all mechanical deficiency, and certainly the astonishing progress of electricity as applied to telegraphy, and to those marvellous instruments of recent invention which the British Post Office claims to include in its monopoly of the electric telegraph, as well as the wonderful advance which electricity has made as an illuminating agent, does tend to impress us with faith in its future greatness in the realm of motive power as well.

The difference between heat and electricity in their modes of mechanical action is very wide. Heat acts by expansion of volume which we know to be a necessarily wasteful principle, while electricity operates by attraction and repulsion, and thus produces motion in a manner which is subject to no greater loss of effect than attends the motive action of gravity as exemplified in the ponderable application of falling water in hydraulic machines. If then we could produce electricity with the same facility and economy as heat, the gain would be enormous, but this, as yet at least, we cannot do. At present by far the cheapest method of generating electricity is by the dynamic process. Instead of beginning with electricity to produce power, we begin with power to produce electricity. As a secondary motor an electric engine may, and assuredly will, play an important part in future applications of power, but our present inquiry relates to a primary, and not a secondary, employment of electricity. Thus we are brought to the question, from what source, other than mechanical action, can we hope to obtain a supply of electricity sufficiently cheap and abundant to enable it to take the place of heat as a motive energy? It is commonly said that we know so little of the nature of electricity that it is impossible to set bounds to the means of obtaining it; but ignorance is at least as liable to mislead in the direction of exaggerated expectation as in that of incredulity. It may be freely admitted that the nature of electricity is much less understood than that of heat, but we know that the two are very nearly allied. The doctrine that heat consists of internal motion of molecules may be accepted with almost absolute certainty of its truth. The old idea of heat being a separate entity is no longer held except by those who prefer the fallacious evidence of their senses to the demonstrations of science. So also the old idea of electricity having a separate existence from tangible matter must be discarded, and we are justified in concluding that it is merely a strained or tensional condition of the molecules of matter. Although electricity is more prone to pass into heat than heat into electricity, yet we know that they are mutually convertible. In short I need scarcely remind you, that according to that magnificent generalization of modern times, so pregnant with great consequences, and for which we are indebted to many illustrious investigators, we now know that heat, electricity, and mechanical action, are all equivalent and transposable forms of energy, of which motion is the essence.

To take a cursory view of our available sources of energy, we have, firstly, the direct heating powers of the

sun's rays, which as yet we have not succeeded in applying to motive purposes. Secondly we have water power, wind power, and tidal power, all depending upon influences lying outside of our planet. And thirdly we have chemical attraction or affinity. Beyond these there is nothing worth naming. Of the radiant heat of the sun I shall have to speak hereafter, and bearing in mind that we are in search of electricity as a cause, and not an effect, of motive power we may pass over the dynamical agencies comprised under the second head, and direct our attention to chemical affinity as the sole remaining source of energy available for our purpose. At present we derive motive power, from chemical attraction through the medium of heat only, and the question is, can we with advantage draw upon the same source through the medium of electricity. The process by which we obtain our supply of heat from the exercise of affinity is that of combustion, in which the substances used consist, on the one hand, of those we call fuel, of which coal is the most important, and on the other, of oxygen, which we derive from the atmosphere. The oxygen has an immense advantage over every other available substance in being omnipresent and costless. The only money value involved is that of the fuel, and in using coal we employ the cheapest oxidizable substance to be found in nature. Moreover the weight of coal used in the combination is only about one-third of the weight of oxygen, so that we only pay upon one-fourth of the whole material consumed. Thus we have conditions of the most favorable description for the production of energy, in the form of heat, and if we could only use the affinities of the same substances with equal facility to evolve electric energy instead of heat energy, there would be nothing more to desire; but as yet there is no appearance of our being able to do this. According to our present practice we consume zinc, instead of coal, in the voltaic production of electricity, and not only is zinc thirty or forty times dearer than coal, but it requires to be used in about six-fold larger quantity in order to develop an equal amount of energy. Some people are bold enough to say that with our present imperfect knowledge of electricity we have no right to condemn all plentiful substances, other than coal, as impracticable substitutes for metallic zinc, but it is manifest that we cannot get energy from affinity, where affinity has already been satisfied. The numerous bodies which constitute the mass of our globe, and which we call earths, are bodies in this inert condition. They have already, by the union of the two elements composing them, evolved the energy due to combination, and that energy has ages ago been dissipated in space in the form of heat, never again to be available to us. As well might we try to make fire with ashes, as to use such bodies over again as sources of either heat or electricity. To make them fit for our purpose, we should first have to annul their state of combination, and this would require the expenditure of more energy upon them than we could derive from their recombination. Water, being oxidized hydrogen, must be placed in the same category as the earths. In short, the only abundant substances in nature possessing strong unsatisfied affinities are those of organic origin, and in the absence of coal, which is the accumulated product of a past vegetation, our supply of such substances would be insignificant. This being the case, until a means be found of making the combination of coal with oxygen directly available for the development of electric energy, as it now is of heat energy, there seems to be no probability of our obtaining electricity from chemical action at such a cost as to supplant heat as a motive agent.

But while still looking to heat as the fountain-head of our power, we may very possibly learn to transmute it, economically, into the more available form of electricity. One method of transformation we already possess, and we have every reason to believe there are others yet to be discovered. We know that when dissimilar metals

are joined at opposite ends, and heated at one set of junctions while they are cooled at the other, part of the heat applied disappears in the process, and assumes the form of an electric current. Each couple of metals may be treated as the cell of a voltaic battery, and we may multiply them to any extent, and group them in series or in parallels, with the same results as are obtained by similar combinations of voltaic cells. The electricity so produced we term Thermo-electricity, and the apparatus by which the current is evolved is the thermo-electric battery. At present this apparatus is even more wasteful of heat than the steam-engine, but considering the very recent origin of this branch of electrical science, and our extremely imperfect knowledge of the actions involved, we may reasonably regard the present thermo-electric battery as the infant condition of a discovery, which, if it follow the rule of all previous discoveries in electricity, only requires time to develop into great practical importance. Now if we possessed an efficient apparatus of this description we could at once apply it to the steam-engine for the purpose of converting into electric energy the heat which now escapes with the rejected steam, and the gases from the fire. The vice of the steam-engine lies in its inability to utilize heat of comparatively low grade, but if we could use up the leavings of the steam-engine by a supplemental machine acting on thermo-electric principles, the present excessive waste would be avoided. We may even anticipate that in the distant future a thermo-electric engine may not only be used as an auxiliary, but in complete substitution of the steam-engine. Such an expectation certainly seems to be countenanced by what we may observe in animated nature. An animal is a living machine dependent upon food both for its formation and its action. That portion of the food which is not used for growth or structural repair, acts strictly as fuel in the production of heat. Part of that heat goes to the maintenance of the animal temperature, and the remainder gives rise to mechanical action. The only analogy between the steam engine and this living engine is that both are dependent upon the combustion of fuel, the combustion in the one case being extremely slow, and in the other very rapid. In the steam-engine the motion is produced by pressure, but in the animal machine it is effected by muscular contraction. The energy which causes that contraction, if not purely electrical, is so much of that nature that we can produce the same effect by electricity. The conductive system of the nerves is also in harmony with our conception of an electrical arrangement. In fact a description of the animal machine so closely coincides with that of an electro-dynamic machine actuated by thermo-electricity, that we may conceive them to be substantially the same thing. At all events, the animal process begins with combustion and ends with electrical action, or something so nearly allied to it as to differ only in kind. And now observe how superior the result is in nature's engine to what it is in ours. Nature only uses heat of low grade, such as we find wholly unavailable. We reject our steam as useless at a temperature that would cook the animal substance, while nature works with a heat so mild as not to hurt the most delicate tissue. And yet, notwithstanding the greater availability of high-grade temperature the quantity of work performed by the living engine relatively to the fuel consumed, puts the steam-engine to shame. How all this is done in the animal organization we do not yet understand, but the result points to the attainability of an efficient means of converting low-grade heat into electricity, and in striving after a method of accomplishing that object we shall do well to study nature, and profit by the excellence which is there displayed.

But it is not alone in connection with a better utilization of the heat of combustion that thermo-electricity bears so important an aspect, for it is only the want of an efficient apparatus for converting heat into electricity that prevents our using the direct heating action of the

sun's rays for motive power. In our climate, it is true, we shall never be able to depend upon sunshine for power, nor need we repine on that account so long as we have the preserved sunbeams which we possess in the condensed and portable form of coal, but in regions more favored with sun and less provided with coal the case would be different. The actual power of the sun's rays is enormous, being computed to be equal to melting a crust of ice 103 feet thick over the whole earth in a year. Within the tropics it would be a great deal more, but a large deduction would everywhere have to be made for absorption of heat by the atmosphere. Taking all things into account, however, we shall not be far from the truth in assuming the solar heat, in that part of the world, to be capable of melting annually, at the surface of the ground, a layer of ice 85 feet thick. Now let us see what this means in mechanical effect. To melt 1 lb. of ice requires 142.4 English units of heat, which, multiplied by 772, gives us 109,932 foot pounds as the mechanical equivalent of the heat consumed in melting a pound of ice. Hence we find that the solar heat, operating upon an area of one acre, in the tropics, and competent to melt a layer of ice 85 feet thick in a year, would, if fully utilized, exert the amazing power of 4000 horses acting for nearly nine hours every day. In dealing with the sun's energy we could afford to be wasteful. Waste of coal means waste of money and premature exhaustion of coal beds. But the sun's heat is poured upon the earth in endless profusion—endless at all events in a practical sense, for whatever anxiety we may feel as to the duration of coal, we need have none as to the duration of the sun. We have therefore only to consider whether we can divert to our use so much of the sun's motive energy as will repay the cost of the necessary apparatus, and whenever such an apparatus is forthcoming we may expect to bring into subjection a very considerable proportion of the 4000 invisible horses which science tells us are to be found within every acre of tropical ground.

But whatever may be the future of electricity as a prime mover, either in a dominant or subordinate relation to heat, it is certain to be largely used for mechanical purposes in a secondary capacity, that is to say, as the offspring instead of the parent of motive power. The most distinctive characteristic of electricity is that which we express by the word "current," and this gives it great value in cases where power is required in a transmissible form. The term may be objected to as implying a motion of translation analogous to the flow of a liquid through a pipe, whereas the passage of electricity through a conductor must be regarded as a wave-like action communicated from particle to particle. In the case of a fluid current through a pipe, the resistance to the flow increases as the square of the velocity, while in the case of an electric current the resistance through a given conductor is a constant proportion of the energy transmitted. So far therefore as resistance is concerned electricity has a great advantage over water for the transmission of power. The cost of the conductor will however be a grave consideration where the length is great, because its section must be increased in proportion to the length to keep the resistance the same. It must also be large enough in section to prevent heating, which not only represents loss but impairs conductivity. To work advantageously on this system, a high electromotive force must be used, and this will involve loss by imperfect insulation, increasing in amount with the length of the line. For these reasons there will be a limit to the distance to which electricity may be profitably conveyed, but within that limit there will be wide scope for its employment transmissively. Whenever the time arrives for utilizing the power of great waterfalls the transmission of power by electricity will become a system of vast importance. Even now small streams of water inconveniently situated for direct application may, by the adoption of this principle, be brought into useful operation.

For locomotive purposes also we find the dynamo-

electric principle to be available, as instanced in the very interesting example presented in Siemens' electric railway, which has already attained that degree of success which generally foreshadows an important future. It forms a combined fixed engine and locomotive system of traction, the fixed engine being the generator of the power and the electric engine representing the locomotive.

Steam power may both be transmitted and distributed, by the intervention of electricity, but it will labor under great disadvantage when thus applied, until a thoroughly effective electric accumulator be provided, capable of giving out electric energy with almost unlimited rapidity. How far the secondary battery of M. Faure will fulfill the necessary conditions remains to be seen, and it is to be hoped that the discussions which may be expected to take place at this meeting of the British Association will enable a just estimate of its capabilities to be formed. The introduction of the Faure battery is at any rate a very important step in electrical progress. It will enable motors of small power, whatever their nature may be, to accomplish, by uninterrupted action, the effect of much larger machines acting for short periods, and by this means the value of very small streams of water will be greatly enhanced. This will be especially the case where the power of the stream is required for electric lighting, which, in summer, when the springs are low, will only be required during the brief hours of darkness, while in winter the longer nights will be met by a more abundant supply of water. Even the fitful power of wind, now so little used, will probably acquire new life when aided by a system which will not only collect, but equalize, the variable and uncertain power exerted by the air.

It would greatly add to the utility of the Faure battery if its weight and size could be considerably reduced, for in that case it might be applicable to many purposes of locomotion. We may easily conceive its becoming available in a lighter form for all sorts of carriages on common roads, thereby saving to a vast extent the labor of horses. Even the nobler animal that strides a bicycle, or the one of fainter courage that prefers the safer seat of a tricycle, may ere long be spared the labor of propulsion, and the time may not be distant when an electric horse, far more amenable to discipline than the living one, may be added to the bounteous gifts which science has bestowed on civilized man.

In conclusion I may observe that we can scarcely sufficiently admire the profound investigations which have revealed to us the strict dynamical relation of heat and electricity to outward mechanical motion. It would be a delicate task to apportion praise amongst those whose labors have contributed, in various degrees, to our present knowledge; but I shall do no injustice in saying that of those who have expounded the modern doctrine of energy, in special relation to mechanical practice, the names of Joule, Clausius, Rankine, and William Thomson, will always be conspicuous. But up to this time our knowledge of energy is almost confined to its inorganic aspect. Of its physiological action we remain in deep ignorance, and as we may expect to derive much valuable guidance from a knowledge of Nature's methods of dealing with energy in her wondrous mechanisms, it is to be hoped that future research will be directed to the elucidation of that branch of science which as yet has not even a name, but which I may provisionally term "Animal Energetics."

The dark violet fluor-spar of Wölsendorf contains some strongly odorous substance, the nature of which has not hitherto been satisfactorily explained. From recent experiments (described to the Berlin Chemical Society,) Herr Low concludes that the smell is due to presence of *free fluorine*, arising on elevation of temperature through dissociation of a small quantity of fluoride, (probably ceric fluoride).

CORRESPONDENCE.

To the Editor of "SCIENCE."

It seems to me that Pres. Gaines' objection to the accepted theory of vision (see SCIENCE of Aug. 6, p. 370) may easily be answered.

It is universally agreed that vision is a sensation produced by ethereal undulations, and that these undulations are induced by molecular motion in a luminous body. Each point of a luminous body is a radiant point, that is, emits rays of light in every direction, and it is by some of these rays of ethereal undulations, either directly from the luminous point or refracted by, or reflected from, some non-luminous body, that all impressions of vision are made. Hence, all non-luminous objects are manifested to vision by reflected light, but reflected light is also *radiant* light; that is, reflected ethereal waves radiate from every point of non-luminous objects manifested to vision. These waves have fallen upon the reflecting surface (not necessarily a minimum surface or front) from various directions, many of them reflected from other non-luminous objects, and, the angle of reflexion being the same as the angle of incidence, they necessarily *radiate* from the object; and by their difference of intensity, that is, by the different capacities of contiguous surfaces to reflect rays in a particular direction, we receive different impressions from the different parts of the object, and hence assign to the object peculiarities corresponding to the peculiarities of the sensations produced. Hence, though I admit that we become cognizant of objects by radiant light, I contend that in all cases where the object is not self-luminous, the rays

that impress us are reflected rays produced by some luminous body of which we learn nothing from these reflected rays.

J. E. HENDRICKS.
DES MOINES.

ANOTHER CONFIRMATION OF PREDICTION.

BY PLINY EARLE CHASE, LL.D.

On the 4th of October, 1878, I presented a communication to the American Philosophical Society,* in which I showed that the position of Watson's first intra-Mercurial planet, as computed by Gaillot and Monchez, represented the third intra-Mercurial term of my harmonic series. At the last meeting of the British Association, Professor Balfour Stewart read a paper in which he gave indications of sun spot disturbances by a planet, revolving in 24.011 days, and consequently having a semi-axis major of .163. This confirmation, both of my own prediction,† and of the calculations of the French astronomers, is the more interesting, because the first confirmation of my series was contained in a communication which was made to the Royal Society by Messrs. De la Rue, Stewart and Loewy, forty-one days after I had announced the series to the Philosophical Society, and published it in the New York Tribune.‡ The accordances are as follows:

PREDICTION.

CONFIRMATION.

1st interior harmonic term .267. De la Rue, S. & L. .267
3d " " " .165. } Gaillot & Monchez .164
Stewart - - .163

*Proc. A. P. S., xviii., 34-6.

†Ib., xiii., 238.

‡Ib., p. 470.

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING OCT. 29, 1881.

Latitude 40° 45' 58" N.; Longitude 73° 57' 58" W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

BAROMETER.						THERMOMETERS.									
OCTOBER.	MEAN FOR THE DAY.		MAXIMUM.		MINIMUM.		MEAN.		MAXIMUM.			MINIMUM.			MAXIMUM
	Reduced to Freezing.	Reduced to Freezing.	Time.	Reduced to Freezing.	Time.	Dry Bulb.	Wet Bulb.	Dry Bulb.	Time.	Wet Bulb.	Time.	Dry Bulb.	Time.	Wet Bulb.	In Sun.
Sunday, 23--	29.989	30.104	0 a. m.	29.848	12 p. m.	60.6	56.3	69	4 p. m.	60	4 p. m.	51	7 a. m.	51	125.
Monday, 24--	29.640	29.848	0 a. m.	29.508	12 p. m.	57.3	56.6	61	0 a. m.	58	0 a. m.	54	12 p. m.	54	69.
Tuesday, 25--	29.415	29.503	0 a. m.	29.338	2 p. m.	57.0	54.0	64	4 p. m.	60	4 p. m.	52	5 a. m.	52	108.
Wednesday, 26--	29.810	29.982	12 p. m.	29.500	0 a. m.	45.3	40.7	55	0 a. m.	50	0 a. m.	38	12 p. m.	37	110.
Thursday, 27--	30.015	30.058	9 a. m.	29.982	0 a. m.	48.6	43.0	59	4 p. m.	49	4 p. m.	34	6 a. m.	34	109.
Friday, 28--	30.113	30.136	9 a. m.	30.012	0 a. m.	51.7	45.3	56	2 p. m.	48	2 p. m.	44	6 a. m.	41	94.
Saturday, 29--	30.020	30.112	0 a. m.	29.910	12 p. m.	59.3	57.3	62	12 p. m.	61	12 p. m.	54	0 a. m.	48	64.

Mean for the week..... 29.857 inches.
Maximum for the week at 9 a. m., Oct. 28th 30.135 "
Minimum " at 2 p. m., Oct. 25th 29.338 "
Range798 "

Mean for the week..... 54.2 degrees. Wet. 50.4 degrees.
Maximum for the week at 4 p. m. 23d 69. " at 4 p. m. 23d, 60. "
Minimum " at 6 a. m. 27th 34. " at 6 a. m. 27th, 34. "
Range " " 35. " 25. "

WIND.							HYGROMETER.						CLOUDS.			RAIN AND SNOW					OZONE.
OCTOBER.	DIRECTION.			VELOCITY IN MILES.	FORCE IN LBS. PER SQ. FEET.		FORCE OF VAPOR.			RELATIVE HUMIDITY.			CLEAR, OVERCAST.			DEPTH OF RAIN AND SNOW IN INCHES.					
	7 a. m.	2 p. m.	9 p. m.	Distance for the Day.	Max.	Time.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	Time of Begin- ning.	Time of End- ing.	Dura- tion. h. m.	Amount of water		
Sunday, 23-	w. s. w.	s. w.	s. w.	225	3½	3 pm	.374	.380	.447	100	55	77	0	2 cu.	10	4.50 am 10 pm	2 pm 11 pm	9.10 1.00	.19 .01		
Monday, 24-	w.	n. e.	e.	124	¾	10 pm	.482	.436	.436	100	93	93	10	10	10						
Tuesday, 25-	e.	w. s. w.	w. n. w.	116	4¾	7.15 pm	.388	.443	.309	100	82	64	10	7 cu.	0						
Wednesday, 26-	n. w.	n. w.	n.	338	9¾	10.15 am	.228	.162	.190	76	45	74	0	0	0						
Thursday, 27-	w. n. w.	w.	w. s. w.	163	2½	4 pm	.204	.191	.231	100	41	55	0	0	0						
Friday, 28-	n. e.	n. e.	e.	93	1½	0.10 pm	.192	.230	.244	61	51	60	4 cir. cu.	0	10	10	10	10	10	10	
Saturday, 29-	e.	s. s. e.	s. s. e.	220	7¼	12 m	.321	.505	.523	74	94	94	10	10	10	3.15 am	12 pm	20.45	.37		
Distance traveled during the week.....							1,279		miles.		Total amount of water for the week.....							.57		inches.	
Maximum force.....							9½		lbs.		Duration of rain.....							1 day, 6 hours, 55 minutes.			

Distance traveled during the week..... 1,279 miles.
Maximum force..... 9¼ lbs.

Total amount of water for the week..... .57 inch.
Duration of rain..... 1 day, 6 hours, 55 minutes.

DANIEL DRAPER, Ph. D.

Director Meteorological Observatory of the Department of Public Parks, New York.